

OBSERVATIONS & RECOMMENDATIONS

Following is a summary of the current year and historical data collected at each of the **LAKE SUNAPEE TRIBUTARY STATIONS**.

OVERALL SUMMARY

pH:

Tributary pH ranged from **4.78 (Station 1417)** to **7.33 (Station 1420)** during the **2007** sampling season. Since pH is largely affected by natural conditions (the presence of granite bedrock) and acid precipitation, there is little that can be feasibly done to effectively increase tributary and lake pH. Therefore, the LSPA is considering monitoring specific stations of concern in future years.

Conductivity:

A **wide range** in tributary conductivity levels continued during the **2007** sampling season. Specifically, the conductivity ranged from **20.3 uMhos/cm (Station 760)** to **1,103 uMhos/cm (Station 835)**. The **2007** conductivity results for many of the tributaries **increased** in 2007. It is likely that the dry weather conditions in **2007** concentrated the ion content in surface waters throughout the watershed. Overall, the mean annual conductivity has **gradually increased** in the majority of the tributaries since monitoring began. There are numerous stations in the watershed where the conductivity level was **relatively high (greater than 100 uMhos/cm on at least one sampling event)** during the **2007** sampling season. These stations include **Stations 670, 670.5, 675, 680, 720.1, 788, 805, 830, 830.1, 830.2, 835, 1417, 1418, 505, 510, and 515.1**.

Typically, sources of **elevated and/or increasing** conductivity are due to human activity. These sources include effluent from septic systems that eventually seeps into the groundwater (and ultimately into the tributaries and the lake), effluent from waste water treatment plants, agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

It is likely that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in many of the

tributaries and in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **epilimnion** at each deep spot station be sampled for chloride and sodium next season. In addition, at a minimum, the tributaries with extremely high conductivity levels **greater than 500 uMhos/cm (Stations 515.1 and 835)** should be sampled for chloride and sodium. However, it would be best if all stations with conductivity levels **greater than 100 uMhos/cm** be sampled for chloride and sodium so that we can better understand what might be causing the overall increase in conductivity in the tributary, nearshore, and deep spot stations. It is most appropriate to conduct tributary chloride and sodium sampling in the spring during snow melt and during rain events.

Please note that chloride samples can be analyzed free of charge in the Limnology Center Laboratory at DES in Concord. Please contact the VLAP Coordinator to discuss the logistics of this additional sampling.

Total Phosphorus:

A **wide range** in tributary total phosphorus concentrations occurred this season. There are a few stations in the watershed where the total phosphorus concentration was **relatively high (greater than 25 ug/L on at least one sampling event)** during the 2007 sampling season. These stations include **Stations 1115, 670, 670.5, 680, 720.1, 800, 805, 830, 830.1, 830.2, and 1418.**

Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, soil erosion, and natural wetlands.

It is important to note that an elevated total phosphorus concentration in a sample can indicate that the stream bottom was disturbed when the sample was taken (as indicated by an elevated turbidity level). When the stream bottom is disturbed, sediment, which typically contains phosphorus, is released into the water column. When collecting samples in the tributaries, volunteer monitors should sample where the stream is flowing and where the stream is deep enough to collect a "clean" sample.

Turbidity:

There was a wide range in tributary turbidity levels during the 2007 sampling season. A few watershed stations had **relatively high** turbidity levels (**3 NTUs or greater on at least one sampling event**). These stations include **Stations 1115, 670, 670.5, 680, 720.1, 800, 805, 830, 830.1, and 515.1.**

Suspended matter, such as organic detritus, clay, silt, and algae, causes turbidity in the water. Water clarity is strongly influenced by turbidity.

An elevated tributary turbidity level typically indicates that soil erosion is occurring in the watershed or that the stream bottom was disturbed while sampling.

E.coli:

The LPSA has discontinued sampling for *E. coli* as a routine parameter for tributary stations due to the relatively low *E. coli* levels that have been found in the tributary samples and the nearshore station samples in the past. The LPSA has decided to collect *E. coli* samples on a case-by-case basis when there is a reason to suspect that there is a problem. DES agrees that *E. coli* and optical brighteners testing should be conducted when there is a suspected problem (such as failing septic systems, animal waste, or waterfowl waste).

However, DES recommends that E. coli samples be collected whenever storm event samples are taken since fecal matter may be washed into tributaries during storm events. The DES Beach Program has accumulated data that shows E. coli counts increase during and after rainfall events.

TRIBUTARY STATION SUMMARY (BY INDIVIDUAL STATION):

Lake Sunapee Tributary Station Overall Summary (2007)

Stn.	Conductivity Range (uMhos/cm) (min – max)	Total Phosphorus Range (ug/L)	Turbidity Range (NTUs)	pH Range	Land Uses and Potential Pollutant Concerns (as indicated on field data sheet by volunteer monitors)
1115	34.80 – 63.80	6 - 40	1.11 – 9.60	5.75 – 6.50	
1410	21.50 – 45.00	6 - 20	0.42 – 2.37	5.34 – 6.67	
1417	165.2 – 335.0	9 - 25	1.25 – 2.87	4.78 – 6.15	
1418	161.0 – 295.0	11 - 36	2.40 – 3.36	5.35 – 6.09	
1420	65.10 - 86.20	<5 - 7	0.54 - 2.36	5.92 – 7.33	7/11/07: Raging thunderstorms during preceding night.
505	91.30 – 124.40	<5 – 8	0.33- 1.30	6.12 – 6.83	8/13/07: Trash on stream bank (beer bottles, plastic soda bottle, paper and plastic). 10/9/07: Sampling site downstream 50-100 ft.; all saplings cut and lying in the middle of streambed.

Stn.	Conductivity Range (uMhos/cm) (min-max)	Total Phosphorus Range (ug/L)	Turbidity Range (NTUs)	pH Range	Land Uses and Potential Pollutant Concerns (as indicated on field data sheet by volunteer monitors)
510	70.40 – 265.0	<5 - 13	0.40 - 1.78	6.31 - 6.52	7/11/07: Landowner piling logs on bank 7- 8 ft. from sampling point. 8/13/07: Very low, very slow (stagnant). Full of orange, slimy growth on bottom. 8/27/07: Strange odor prevails at site along with brownish bottom
515.1	247.0 - 700.0	<5 – 20	0.95 – 9.50	6.27 – 6.53	9/10/07: Very low flow
540	24.90 - 33.00	8 - 22	0.50 - 1.30	4.96 – 5.52	
610	82.10 – 85.20	<5 - 17	0.43 - 0.84	6.29 – 6.56	
670	102.5 – 201.0	9 - 54	1.00 – 15.60	6.00 – 6.54	10/8/07: Muddy water
670.5	100.6 – 167.1	12 - 64	0.62 – 3.31	5.71 – 6.45	10/8/07: Muddy water
675	34.40 – 180.4	<5 - 23	0.26 – 2.68	6.19 – 6.72	10/8/07: Muddy water
680	25.00 – 216.0	<5 – 58	0.76 – 25.60	6.28 – 7.21	10/8/07: Muddy water
720.1	72.00 – 117.80	7 - 250	0.85 – 31.70	5.52 – 6.09	5/7/07: Some trash/debris in water from local businesses. 6/5/07: Some silt stirred up by local sump pump. 8/20/07: Bottom cloudy and rust colored, flow very low. 9/17/07: Flow appeared non- existent. Took samples just incase. Feel free to dispose of samples if no good.
750	48.50 – 73.70	<5 – 6	0.30 – 2.03	5.91 – 6.13	
760	20.30 – 29.60	5 - 11	0.30 – 0.85	6.18 – 6.46	5/8/07: Three eroded/exposed areas; two are less than one ft. wide. Other is 3-4 ft. wide just above the large rip-rap. 7/8/07: Too low to sample. 8/14/07: Brook is dry.
788	88.00 – 137.1	6 - 14	0.63 – 1.59	6.22 – 6.67	
790	36.00 – 61.70	10 - 21	0.45 – 2.25	6.02 – 6.63	8/6/07: Water seems very brown.
790.2	29.00 - 46.20	9 – 24	0.58 - 1.50	5.85 – 6.37	
790.4	24.00 - 39.10	8 – 20	0.45 – 1.26	5.50 – 6.16	

LAKE SUNAPEE ANNUAL REPORT
TRIBUTARY STATIONS

2007

Stn.	Conductivity Range (uMhos/cm) (min-max)	Total Phosphorus Range (ug/L)	Turbidity Range (NTUs)	pH Range	Land Uses and Potential Pollutant Concerns (as indicated on field data sheet by volunteer monitors)
800	36.90 – 80.50	9 - 33	0.65 – 5.09	6.03 – 6.65	6/5/07: Slightly murky. 7/10/07: Dark tea colored. Dark plant growth on rocks. 9/10/07: Very silty, murky. 10/9/07: Much dark brown sediment.
800.5	29.00 – 54.00	7 - 17	0.50 – 1.69	5.98 – 6.32	5/7/07: Road washed during the big storm.
800.8	25.00 – 51.10	7 - 18	0.28 - 1.20	6.03 – 6.44	5/7/07: The road was washed out during the big storm. 8/15/07: No samples, brook is dry.
805	69.40 - 128.10	5 - 37	0.33 – 3.68	5.77 – 6.67	8/14/07: Sampled upstream 100 yds. To get flow. Much fallen tree and brush debris, bends in brook, above many small sand bars. 9/10/07: Silt.
830	231.0 - 327.0	5 - 84	2.00 - 17.30	5.93 – 6.28	5/8/07: Kind of a sulfur smell. Still beaver dam – water brown. 6/5/07: Dirty and very foamy. 7/9/07: Dark, sudsy and turbid.
830.15	275.0 - 340.0	24 - 135	1.66 – 13.10	5.84 – 6.02	5/8/07: Sampled at dam. Lower (below dam) is ponded (has been for 2-3 yrs.) and backed up to upper wetland. 6/6/07: Site is “ponded” by beavers. Gauge is not visible from top of concrete. 7/10/07: Stagnant.
830.2	195.5 – 277.0	43 - 311	2.10 – 40.70	5.82 – 6.09	5/8/07: Very recent (additional) beaver activity (trees down). 6/6/07: Above normal water level.
835	378.0 – 1103.0	<5 - 57	0.37 – 1.59	6.46 – 6.99	8/14/07: Two eroded/exposed areas; one is 3 ft., one is 8 ft. 10/9/07: Owner has put two boards across to ease stream crossing.

Note: Shaded cells with bold text indicate parameter results that are elevated, or showed a wide range, and, therefore, are of concern. Generally, this applies to conductivity values greater than 100 uMhos/cm, total phosphorus values greater than 25 ug/L, turbidity values greater than 3.0 NTUs, and pH values less than 5.0 units. Advanced sampling should be conducted at these stations, including bracket sampling, to locate pollution sources.

TRIBUTARY RECOMMENDATIONS:

There are numerous tributary sampling stations in the Lake Sunapee watershed where the levels of conductivity, phosphorus, and/or turbidity are of concern. Ideally, it would be best if each of these sample locations could be thoroughly investigated by conducting stream surveys, bracket sampling, and rain event sampling to identify specific sources of pollutant loading. With a limited staff and trained volunteers and limited budget, we realize that LSPA will need to prioritize additional sampling needs. DES suggests that the tributary systems which contribute the largest amount of stream flow to the lake be investigated first, as discussed below:

➤ **STATION 505 (Otter Brook):**

Conductivity: ranged from **93.13** to **124.40 uMhos/cm**. This is a relatively **large** range. The annual mean has **increased** since monitoring began in 1986.

Total Phosphorus: ranged from **<5** to **8 ug/L**.

Turbidity: ranged from **0.33** to **1.30 NTUs**.

Potential Pollutant Concern:

On **August 13** a large amount of trash was observed at the site. On **October 9** it was noted that tree saplings had been cut along the banks and were in the stream.

Other Information:

According to a study conducted by the University of New Hampshire Freshwater Biology Group in 1989 ("Lake Sunapee Nutrient Budget Study"), flow from Otter Brook accounts for approximately **53.5 percent** of the total stream inflow and **12 percent** of the total phosphorus input into the lake. This study indicates that Otter Brook contributes the **largest** amount of stream flow into the lake each year compared to the other tributaries.

Recommendations:

1. This tributary should be monitored on a monthly basis during the summer season and periodically throughout the year during rain events.
2. We encourage LSPA to work cooperatively with the owners of the assisted living facility to encourage responsible stewardship of the lake. A site inspection should be conducted to determine if the site is contributing overland runoff to the brook and the lake and if there are any ways to infiltrate runoff on-site and/or direct it away from the brook or lake.
3. It is possible that road salt use on the roadways and parking lots in this area of the watershed is contributing to the elevated and overall increasing conductivity concentration at this station. Therefore, it is recommended that chloride and sodium samples be collected at this station and submitted to the state chemistry laboratory for analysis.

4. Please report any cutting of stream bank vegetation to the DES Wetlands Bureau. Removal of vegetation can lead to bank erosion and sedimentation of the brook.

➤ **STATION 515.1(Eagle Rock Brook Upstream)**

Conductivity: ranged from **247 to 700 uMhos/cm**. This is a very *large* range.

Phosphorus: ranged from **<5 to 20 ug/L**.

Turbidity: ranged from **0.95 to 9.50 NTUs**.

Potential Pollutant Concern: On the **September 10** sampling event, the volunteer monitor indicated low flow conditions at the site. These conditions can concentrate nutrients and elevate conductivity levels.

Recommendations:

1. It is possible that road salt use on the roadways and parking lots is contributing to the elevated and overall increasing conductivity concentration at this station. Therefore, it is recommended that chloride and sodium samples be collected at this station and submitted to the state chemistry laboratory for analysis.

➤ **STATION 670's (Stations 670 and 670.5 - Chandler Brook Sites)**

Conductivity: ranged from **100.6 to 201.0 uMhos/cm**.

Phosphorus: ranged from **9 to 64 ug/L**.

Turbidity: ranged from **0.62 to 15.60 NTUs** (at Station **670** on the **October 8** sampling) which is a very *large* range.

Potential Pollutant Concern: On the **October 8** sampling event, the volunteer monitor indicated that the water was muddy. Field data indicate 0.5 inches of rainfall occurred 24 hours prior to sampling.

Other Information:

According to the "Lake Sunapee Nutrient Budget Study" (UNH, 1989), flow from Chandler Brook accounts for **9.8 percent** of the total streamflow and **4.2 percent** of the total phosphorus loading into the lake.

Recommendations:

1. Due to the relatively significant percentage of the total stream flow this brook contributes to the lake, this station should continue to be monitored monthly during the sampling season and also during storm events.
2. A stream survey should be conducted along this tributary to identify sources of elevated conductivity and also of erosion.
3. It is possible that road salt use is contributing to the elevated conductivity concentration along this brook. Therefore, it is recommended that chloride and sodium samples be collected at these stations and submitted to the state chemistry laboratory for analysis.
4. Street sweeping should be conducted during late winter before the spring rains to remove accumulated sediment and sand along the roadways in this area.

➤ **STATION 675 (Johnson Brook):**

Conductivity: ranged from **34.4** to **180.4 uMhos/cm**, which is a **large** variation. The conductivity was highest on the **September 4** sampling event and was **relatively low** on the **October 8** sampling event.

Total Phosphorus: ranged from **<5 to 23 ug/L**, which is a large range.

Turbidity: ranged from **0.26** to **2.68 NTUs**.

Potential Pollutant Concern: On **October 8** the volunteer noted muddy water conditions. Field data indicate 0.5 inches of rainfall occurred 24 hours prior to sampling.

Other Information:

According to the “Lake Sunapee Nutrient Budget Study” (UNH, 1989), flow from Johnson Brook accounts for **4.3 percent** of the total stream flow and **3.4 percent** of the total phosphorus input into the lake.

Recommendations:

1. Due to the relatively significant percentage of the total stream flow this brook contributes to the lake, this station should continue to be monitored monthly during the sampling season and also during storm events.
2. It is possible that road salt use is contributing to the elevated and overall increasing conductivity concentration at this station. Therefore, it is recommended that chloride and sodium samples be collected at this station and submitted to the state chemistry laboratory for analysis.

➤ **STATION 790s (Station 790, 790.2, and 790.4 - Blodgett Brook Sites)**

Conductivity: ranged from **24.0** to **61.70 uMhos/cm**. The annual mean conductivity at this station has **increased overall** since monitoring began.

Total Phosphorus: ranged from **8 to 24 ug/L**, which is **relatively low** for these stations. The mean annual concentration at this station has ranged between **6** and **125 ug/L** since monitoring began in 1993.

Turbidity: ranged from **0.45** to **2.25 NTUs**, which is **relatively low** for these stations.

Potential Pollutant Concern: At station **790** on **August 6** the sampler indicated that the water was brown.

Other information:

According to the “Lake Sunapee Nutrient Budget Study” (UNH, 1989), flow from Blodgett Brook accounts for approximately **8 percent** of the total stream flow and **3.9 percent** of the total phosphorus input to the lake.

Overall Recommendations:

1. Due to the relatively significant percentage of the total stream flow Blodgett Brook contributes to the lake, the **790** Stations should continue to be monitored monthly during the sampling season and also during storm events.
2. A stream survey of this brook should be conducted to determine the sources of elevated turbidity and phosphorus. Unstable and unvegetated areas in the vicinity of the brook should be identified and appropriate best management practices should be implemented to minimize surface erosion and the deposition of sediment to the stream.

➤ **STATION 800s (800, 800.5, and 800.8 - Pike Brook Sites):**

Conductivity: ranged between **25.0** and **80.5 uMhos/cm** which is a **large** range.

Total Phosphorus: ranged from **7** to **33 ug/L** which is a **large** range.

Turbidity: ranged from **0.28** to **5.09 NTUs** which is a **large** range.

Potential Pollutant Concern: At Station **800** on **June 5** and **September 10** and **October 9**, the volunteer indicated the water was very murky and silty. At Stations **800.5** and **800.8** on **May 7** the volunteer indicated that the road washed out during a big storm.

Other information:

According to the "Lake Sunapee Nutrient Budget Study" (UNH, 1989), flow from Pike Brook accounts for approximately **2.3 percent** of the total stream flow and **0.5 percent** of the total phosphorus input into the lake.

Overall Recommendations:

1. These stations should continue to be monitored on a monthly basis during the sampling season and also during storm events.
2. It is possible that road salt use is contributing to the elevated conductivity concentration along this brook. Therefore, it is recommended that chloride and sodium samples be collected at these stations and submitted to the state chemistry laboratory for analysis.
3. It is evident that the road erosion is occurring during heavy rain events. We recommend contacting the town to discuss use and installation of erosion control measures at these sites.

➤ **STATION 805 (King Hill Brook):**

Conductivity: ranged from **69.4** to **128.1 uMhos/cm**, which is a relatively **large** range. The annual mean conductivity has **increased** at this station since monitoring began.

Total Phosphorus: ranged from **5** to **37 ug/L**. This is a **large** range.

Turbidity: ranged from **0.33** to **3.68 NTUs**.

Potential Pollutant Concern:

On **September 10** the volunteer indicated silt in the brook.

Other information:

According to the "Lake Sunapee Nutrient Budget Study" (UNH, 1989), flow from King Hill Brook accounts for approximately **14.7 percent** of

the total stream flow into the lake and **5.6 percent** of the phosphorus loading to the lake. Specifically, this indicates that King Hill Brook is the tributary that contributes the **second-largest** amount of stream flow and tributary phosphorus loading into the lake.

Recommendations:

1. Due to the increasing conductivity level in this tributary and the fluctuating turbidity level, combined with the fact that this tributary is the second largest contributor of stream flow into the lake, this station should continue to be monitored on a monthly basis during the sampling season and during storm events.
2. It is possible that stream bank and watershed erosion are occurring along this site. A stream survey should be conducted along this tributary, particularly to identify potential sources of conductivity, phosphorus, and soil erosion.
3. It is possible that road salt use is contributing to the elevated conductivity concentration along this brook. Therefore, it is recommended that chloride and sodium samples be collected at these stations and submitted to the state chemistry laboratory for analysis.

➤ **STATION 830s (Herrick Cove stations 830, 830.15, and 830.2):**
Conductivity: ranged from **195.5** to **340.0 uMhos/cm**, which is a **very large** range. The conductivity at this station has *fluctuated* since monitoring began, but has generally been **very high (more than 200 uMhos/cm)**. The highest reading was at Station **830.15** on **June 6**.

Total Phosphorus: ranged from **5** to **311 ug/L** (at **Station 830.2** on the **August 21** sampling event), which is a very **large** range.

Turbidity: ranged from **1.66** to **40.70 NTUs** (at **Station 830.2** on the **August 21** sampling event). This is a very **large range**. The elevated turbidity indicates that violations of state water quality standards are occurring in this brook.

Potential Pollutant Concern:

Throughout the season the water was backed up at all stations due to a beaver dam. At Station **830** on **June 5** and **July 9** the water was dark, turbid and foamy.

Other Information:

According to the "Lake Sunapee Nutrient Budget Study" (UNH, 1989), flow from North Herrick Cove Brook and Herrick Cove Brook each contribute approximately **0.6 percent** of the total stream flow and **0.5 percent** of the total phosphorus input into the lake. While the flow contribution of each of these brooks to the lake may not seem significant compared to the total inflow into the lake, the flow from these brooks could have significant localized affects on the water quality of Herrick's Cove (a relatively shallow cove).

Overall Recommendations:

1. The Herrick Cove Stations should continue to be monitored closely for increases in conductivity, total phosphorus, and turbidity.

2. Sampling at upstream locations should be continued on a monthly basis.
3. In addition, it is recommended that a stream survey be conducted along Herrick Cove Brook.
4. DES recommends that a field conductivity meter be used during stream surveys to help pinpoint sources of elevated conductivity.
5. It is possible that road salt use is contributing to the elevated conductivity concentration along this brook. Therefore, it is recommended that chloride and sodium samples be collected at these stations and submitted to the state chemistry laboratory for analysis.

➤ **STATION 835 (Herrick Cove North)**

Conductivity: ranged from **378.0** to **1103.0 uMhos/cm**. This is a very **large** range. The conductivity at this site has **fluctuated** since monitoring began but has remained **elevated** generally above **300 uMhos/cm**. The highest reading occurred on **August 14**.

Total Phosphorus: ranged from **<5** to **57 ug/L**. This is a very **large** range. Total phosphorus levels have **fluctuated** at this site since monitoring began. The highest reading occurred on **August 14**.

Turbidity: ranged from **0.37** to **1.59**.

Potential Pollutant Concern:

On **August 14** the volunteer noted two areas of erosion. On **October 9** the volunteer noted a homeowner had put logs across the stream to cross.

Overall Recommendations:

1. This station should continue to be monitored closely for increases in conductivity, total phosphorus, and turbidity.
2. Sampling at an upstream location is recommended.
3. In addition, it is recommended that a stream survey be conducted along Herrick Cove North to identify potential areas of increased conductivity and erosion.
4. DES recommends that a field conductivity meter be used during stream surveys to help pinpoint sources of elevated conductivity.
5. It is possible that road salt use is contributing to the elevated conductivity concentration along this brook. Therefore, it is recommended that chloride and sodium samples be collected at these stations and submitted to the state chemistry laboratory for analysis.